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10/535,279	06/16/2006	Pulickel Ajayan	047182-0140	3895
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EXAMINER				
BARCENA, CARLOS				
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

### Office Action Summary

**Application No.**

10/535,279

**Applicant(s)**

AJAYAN ET AL.

**Examiner**

CARLOS BARCENA

**Art Unit**

4181

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 14 October 2008.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-48 is/are pending in the application.
- 4a) Of the above claim(s) 3, 13-19, 21, 28 and 31-48 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1, 2, 4-12, 20, 22-27, 29 and 30 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date 14 October 2008; 18 May 2005.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_\_

**DETAILED ACTION**

Claims 1 – 48 are pending for application 10/535279 (Attorney Docket No. 047182-0140) but subject to restriction. Claims 1, 2, 4-12, 20, 22-27, 29, and 30 are presented for examination based on the merit.

**DETAILED ACTION**

***Election/Restrictions***

1. Restriction is required under 35 U.S.C. 121 and 372.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In accordance with 37 CFR 1.499, applicant is required, in reply to this action, to elect a single invention to which the claims must be restricted.

Group I, claims 1-30, drawn to a process for producing derivatized, well-dispersed carbon nanotubes.

Group II, claims 31-37, drawn to process for producing derivatized, well-dispersed carbon nanotubes comprising functional groups attached to the carbon nanotube surface.

Group III, claims 38-45, drawn to a process for producing polymer-derivatized, well-dispersed carbon nanotubes.

Group IV, claims 46-48, drawn to a composite material.

The inventions listed as Groups I, II, III, and IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the express “special technical features” is defined as meaning those technical features that define a contribution which each of the inventions, considered as a whole, makes over the prior art.”(Rule 13.2). Unity exists only

when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding claimed special technical features. In this case, the technical feature shared by each invention is derivatized carbon nanotubes. The question of unity of invention has been reconsidered retroactively by the examiner in view of the search performed; a review of the general art makes clear that the inventions of the groups I, II, III, and IV lack the same or corresponding special technical feature the claimed technical feature does not define a contribution which each of the inventions, considered as a whole, makes over the prior art.

2. This application contains claims directed to more than one species of the generic invention. These species are deemed to lack unity of invention because they are not so linked as to form a single general inventive concept under PCT Rule 13.1.

If group I is elected, the species are as follows:

- a) CNT is a SWNT (claim 2) **or** MWNT (claim 3);
- b) matrix is a polyamide, polyester, polyurethane, polysulfonamide, polycarbonate, polyurea, polyphosphonoamide, polyarylate, polyimide, poly(amic ester), poly(ester amide), a poly(enaryloxynitrile) matrix or mixtures thereof (claim 12) **or** matrix is a sulfur containing polymer matrix or a liquid crystalline (LC) thermotropic main-chain polyester and copolyester matrix (claim 13) **or** matrix is a matrix of a poly(ester amide)s related to nylons and polyesters (claim 15) **or** matrix is a matrix of aromatic-aliphatic poly(enaminonitriles) (PEANs), cross-linked polyamide network, cross-linked polyester network, fluorine-containing, methylene-bridged aromatic polyesters or a blue luminescent polyethers (claim 18) **or** matrix is a matrix of polycarbonate/polybutylene terephthalate (PC/PBT), polycarbonate/polyethylene terephthalate (PC/PET), polyamide (PA) reinforced with modified polyphenylene ether (PPE), polyphenylene

suphide (PPS), polybutylene terephthalate (PBT), polyethylene terephthalate (PET), polyetherimide, expandable polystyrene poly(2,6- dimethyl-1,4-phenylene ether (PPE), modified polyphenylene ether (PPE), polycarbonate (PC), acrylic-styrene-acrylonitrile (ASA), polycarbonate/acrylonitrile-butadiene-styrene (PC/AIIS) or acrylonitrile-butadiene-styrene (ABS) (claim 19);

c) the functional groups are directly attached to the CNT surface (claim 20) **or** the functional groups are indirectly attached to the CNT surface (claim 21).

d) functional groups are directly attached to the CNT surface and said functional groups comprise COOH (claim 28) **or** functional groups are indirectly attached to the CNT surface and wherein said functional groups are selected from the group consisting of OH and NH<sub>2</sub> (claim 29).

If group II is elected, the species are as follows:

a) functional groups are directly attached to the CNT surface and said functional groups comprise COOH (claim 35) **or** functional groups are indirectly attached to the CNT surface and wherein said functional groups are selected from the group consisting of OH and NH<sub>2</sub> (claim 36).

Applicant is required, in reply to this action, to elect a single species to which the claims shall be restricted if no generic claim is finally held to be allowable. The reply must also identify the claims readable on the elected species, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered non-responsive unless accompanied by an election.

Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which are written in dependent form or otherwise include all the limitations of an allowed generic claim as provided by 37 CFR 1.141. If claims are added after

the election, applicant must indicate which are readable upon the elected species. MPEP § 809.02(a).

3. The species listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, the species lack the same or corresponding special technical features for the following reasons: the express “special technical features” is defined as meaning those technical features that define a contribution which each of the inventions, considered as a whole, makes over the prior art.”(Rule 13.2). Unity exists only when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding claimed special technical features. In this case, the technical feature shared by each invention is derivatized carbon nanotubes.

4. During a telephone conversation with Leon Radomsky on 10/08/2008 a provisional election was made without traverse to prosecute the invention of a process for producing derivatized, well-dispersed carbon nanotubes, claims 1-30 (Group I and on 10/27/2008 a provisional election was made to prosecute the species of claims 2, 12, 20 and 29. Affirmation of this election must be made by applicant in replying to this Office action. Claims 3, 13, 15, 18, 19, 21, 28, and 31-48 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention. It is also to be noted that claims 14, 16 and 17 are also withdrawn because they depend on non elected claims.

5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the

application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

6. The examiner has required restriction between product and process claims. Where applicant elects claims directed to the product, and the product claims are subsequently found allowable, withdrawn process claims that depend from or otherwise require all the limitations of the allowable product claim will be considered for rejoinder. All claims directed to a nonelected process invention must require all the limitations of an allowable product claim for that process invention to be rejoined.

In the event of rejoinder, the requirement for restriction between the product claims and the rejoined process claims will be withdrawn, and the rejoined process claims will be fully examined for patentability in accordance with 37 CFR 1.104. Thus, to be allowable, the rejoined claims must meet all criteria for patentability including the requirements of 35 U.S.C. 101, 102, 103 and 112. Until all claims to the elected product are found allowable, an otherwise proper restriction requirement between product claims and process claims may be maintained. Withdrawn process claims that are not commensurate in scope with an allowable product claim will not be rejoined. See MPEP § 821.04(b). Additionally, in order to retain the right to rejoinder in accordance with the above policy, applicant is advised that the process claims should be amended during prosecution to require the limitations of the product claims. **Failure to do so may result in a loss of the right to rejoinder.** Further, note that the prohibition against double patenting rejections of 35 U.S.C. 121 does not apply where the restriction requirement is withdrawn by the examiner before the patent issues. See MPEP § 804.01.

***Claim Rejections - 35 USC § 102***

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

**8. Claims 1, 2, and 4 are rejected under 35 U.S.C. 102(b) as being anticipated by Jouguelet *et al.* (Controlling the electronic properties of single-wall carbon nanotubes by chemical doping).**

Regarding applicant claim 1, 2, and 4, Jouguelet discloses doping (derivatizing) single-wall carbon nanotubes (SWNT) with organic radical-anions (ionizing agent) with Li<sup>+</sup> as the counter ion (salts) (abstract).

**9. Claims 1, 2, 7, 8, 20, 22, 25, and 29 rejected under 35 U.S.C. 102(b) as being anticipated by Chen *et al.* (Solution properties of single-walled carbon nanotubes).**

Regarding applicant claim 1 and 2, Chen discloses derivatizing SWNT with thionylchloride and octadecylamine, involving both ionic and covalent solution-phase chemistry (abstract).

Regarding applicant claim 7, 8, 20, 22, 25, and 29, Chen discloses a reaction scheme for attaching functional groups directly on the SWNT including carboxyl, acyl chloride, amine, or amide functionality (p. 96, col. 1, reaction scheme 1). Chen further discloses in the final reaction step grafting a polymer (CH<sub>3</sub>(CH<sub>2</sub>)<sub>17</sub>NH<sub>2</sub>) on the SWNT surface via a functional group.



***Claim Rejections - 35 USC § 103***

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

11. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

12. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

13. **Claims 1, 2, 4-7, 25, and 26 rejected under 35 U.S.C. 103(a) as being unpatentable over Ederlé *et al.* (Carbanions on grafted C<sub>60</sub> as Initiators for anionic polymerization) in view of Jouguelet *et al.* (Controlling the electronic properties of single-wall carbon nanotubes by chemical doping).**

Regarding applicant claim 1, 2, 4, 5, 7, 25 and 26, Ederlé teaches carbanions on grafted C<sub>60</sub> as initiators for anionic polymerizations. Ederlé uses the ionizing agent *s*-BuLi (alkyllithium salt) to derivatize C<sub>60</sub> with polystyrenes as a functional group (p. 4263, Section “In-Out Synthesis of Grafted C<sub>60</sub>, 2<sup>nd</sup> line). Ederlé does not teach SWNT.

Jouguelet discloses doping (derivatizing) SWNT with organic radical-anions (ionizing agent) with Li<sup>+</sup> as the counter ion (salts) (abstract). It would have been obvious to one of ordinary skill in the art at the time of invention to use the method of Ederlé to derivatize SWNT as taught by Jouguelet using alkyllithium salts.

One of ordinary skill in the art would have been motivated to do so because both SWNT and C<sub>60</sub> molecules are closed cage molecules composed of entirely sp<sup>2</sup>-hybridized carbons arranged in hexagons and pentagons.

Regarding applicant claim 6, Ederlé states the using deactivating (quenching) with acidified methanol (p. 4263, Section “In-Out Synthesis of Grafted C<sub>60</sub>, line 5).

**14. Claims 23 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ederlé *et al.* (Carbanions on grafted C<sub>60</sub> as Initiators for anionic polymerization) in view of Jouguelet *et al.* (Controlling the electronic properties of single-wall carbon nanotubes by chemical doping) as applied to claims 1, 2, 4-7, 25, and 26 above, and further in view of Ruoff *et al.* (US Patent 5,547,748).**

Regarding applicant claims 23 and 27, neither Ederlé nor Jouguelet teach the agent that places functional groups attached to the CNT surface is selected from the group consisting of CO<sub>2</sub>, ethylene oxide, or X(alk)NRR' as recited in claim 23 and 27.

Ruoff teaches the surface of nanoencapsulates may be derivatized applying derivatization methods useful with fullerenes and nanotube molecules. Numerous functional groups can be attached to the surface of the nanoencapsulates, including, but not limited to, the following: amines, hydroxyls, carboxyls, ethers, ketones and epoxides. Oxidation of the nanoencapsulates can be accomplished, for example, by heating them in the presence of oxygen, carbon dioxide or carbon monoxide (col. 11, lines 10-25).

It would have been obvious to one of ordinary skill in the art at the time of invention to functionalize a CNT with functional groups as taught by Ederlé and Jouguelet using CO<sub>2</sub> as taught by Ruoff. One would have been motivated to do so because these functional CNT can be further derivatized, using standard coupling reaction chemistry, to couple the nanoencapsulates and a molecule or compound of interest: for example, amino acids, peptides, polypeptides, enzymes, ribosomes, drug molecules, antibodies, avidin, biotin, nucleic acids, polymer monomers and polymers (Ruoff, col. 11, lines 42-48).

**15. Claims 1, 7-12, 24-25 and 30 rejected under 35 U.S.C. 103(a) as being unpatentable over Chen *et al.* (Solution properties of single-walled carbon nanotubes) in view of Smalley *et al.* (US Patent Application Publication US 2002/0068170).**

Regarding applicant claim 1, 7-12, 24-25, and 30, Chen teaches derivatizing SWNT with thionylchloride and octadecylamine, involving both ionic and covalent solution-phase chemistry (abstract). Chen discloses a reaction scheme for attaching functional groups directly on the SWNT including carboxyl, acyl chloride, or amide functionality (p. 96, col. 1, reaction scheme 1). Chen further discloses in the final reaction step grafting a polymer (CH<sub>3</sub>(CH<sub>2</sub>)<sub>17</sub>NH<sub>2</sub>) on the SWNT surface via a functional group.

Chen does not teach further incorporating said derivatized, well dispersed CNT into a matrix or a matrix that is the same or different as the polymer grafted to said derivatized, well dispersed CNT or a matrix where the matrix is a polymer as recited in claim 12 or 24.

Smalley teaches derivatizing CNTs with polymer. Specifically, Smalley teaches derivatizing CNT with various polymers (para. [0041]) and incorporating these derivatized CNT into various polymer matrices (Smalley claim 25, p. 11) such as nylon (poly ester amide), polyester, polyimide, and polyamide. Smalley does not specifically incorporate the polymer grafted-CNT into the same polymer matrix, but does incorporate the grafted-CNT with chemically similar polymers. For example, the CNT can be derivatized with poly(methyl methacrylate-co-ethyl acrylate) into poly(methyl methacrylate) or polystyrene sulfonate derivatized CNT into polystyrene.

Nonetheless, it would have been obvious to one of ordinary skill in the art at the time of invention to derivatize a CNT with a polymer through a functional group as taught by Chen and incorporate the resulting derivatized polymer into a composite as taught by Smalley into the same, chemically similar, or different polymer matrix.

The polymer wrappings or coatings can be chosen to make the polymer-associated SWNTs and ropes of SWNTs compatible with matrices of other materials to facilitate fabrication of composites. Composite materials of polymer-associated SWNTs suspended in a polymer matrix, provide a new form of polymeric composite. This microscopic dimensional compatibility minimizes the propensity of the composite to fail mechanically at the interface between the matrix and the SWNTs, producing a composite material with enhanced mechanical properties such as strain-to-failure, toughness, and resistance to mechanical fatigue (Smalley, para. [0018]).

**16. Claim 23 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen *et al.* (Solution properties of single-walled carbon nanotubes) in view of Smalley *et al.* (US Patent Application Publication US 2002/0068170) as applied to claims 1, 7-12, 24, and 30 above, and further in view of Ruoff *et al.* (US Patent 5,547,748).**

Regarding applicant claims 23 and 27, neither Chen nor Smalley teach the agent that places functional groups attached to the CNT surface is selected from the group consisting of CO<sub>2</sub>, ethylene oxide, or X(alk)NRR' as recited in claims 23 and 27.

Ruoff teaches the surface of nanoencapsulates may be derivatized applying derivatization methods useful with fullerenes and nanotube molecules. Numerous functional groups can be attached to the surface of the nanoencapsulates, including, but not limited to, the following: amines, hydroxyls, carboxyls, ethers, ketones and epoxides. Oxidation of the nanoencapsulates can be accomplished, for example, by heating them in the presence of oxygen, carbon dioxide or carbon monoxide (col. 11, lines 10-25).

It would have been obvious to one of ordinary skill in the art at the time of invention to functionalize a use CNT with functional groups as taught by Chen and Smalley using CO<sub>2</sub> as taught by Ruoff. One would have been motivated to do so because these functional CNT can be further derivatized, using standard coupling reaction chemistry, to couple the nanoencapsulates and a molecule or compound of interest: for example, amino acids, peptides, polypeptides, enzymes, ribosomes, drug molecules, antibodies, avidin, biotin, nucleic acids, polymer monomers and polymers (Ruoff, col. 11, lines 42-48).

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CARLOS BARCENA whose telephone number is (571) 270-5780. The examiner can normally be reached on Monday through Thursday 8AM - 5PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vickie Kim can be reached on (571) 272-0579. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MICHAEL MARCHESCHI/  
Primary Examiner, Art Unit 1793

/C. B./  
Examiner, Art Unit 4181